FERTILIZATION OF A NATIVE HAY MEADOW
IN SOUTHEASTERN OKLAHOMA

By

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PREFACE

This study was conducted to gain further information on the response of native grass hay meadow to rates and combinations of nitrogen and phosphorus in a forty-five inch rainfall area of Oklahoma. The average annual rainfall for the two years of the study was below normal with severe summer drought.

Kind appreciation is expressed to John Harrison, Sr. of Monroe, Oklahoma for the use of a sample area on his native grass meadow during a time when hay was in great demand.

Most sincere thanks are expressed to the members of the writer's graduate committee Drs. Jerry Crockett, Wayne Huffine, Wilfred McMurphy and Bill Tucker for their thoughtful consideration and complete cooperation and assistance beyond measure.

To the writers wife, Margie, and children Ann and Jimmy are given heartfelt thanks for their understanding and willing acceptance of two summers of their life greatly disrupted by the writers conduct of this work.

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INTRODUCTION

Native grass covers an impressive acreage in the land area of Oklahoma with approximately 13,817,500 acres of range and an additional 7,561,700 acres, with a tree canopy of over 10 percent, which are grazed. These areas of native vegetative cover make up more than one half of the 41,122,100 acres of land in the inventory acreage.[1/] Oklahoma has 415,000 acres of native grassland being used for hay production[2/] with ninety percent of this in the eastern one-half of the state (Elder and Murphy 1958).

Since the days when longhorn cattle began to replace the grazers of antiquity, man has sought more production from the native forage. Often this attempt at increased production has been to the detriment of the native cover.

There was a time when the available land and grass exceeded the needs of man. Today that time is looked back upon with a feeling of nostalgia. The ever growing population and the changing economic situation have placed an ever increasing burden on our native grasslands.

1/ Oklahoma Soil and Water Conservation Needs Inventory (1962).

2/ United States Department of Agriculture Statistical Reporting Service (1962)

In view of the fact that the native grasslands make up such a large segment of Oklahoma, anything which will maintain or improve their productive capacity will vitally affect the state's economy. One possible way to improve is through the use of fertilizers.

The cost of fertilizer material has decreased due to technological developments in its manufacture. Mineral elements are now a part of every ranchers vocabulary. Commercial fertilizer is an accepted production tool on most farms in Oklahoma. It is only natural that consideration be given to fertilization of native grass.

In eastern Oklahoma most of the rainfall comes in the warm season and the subsequent leaching of nutrients leave even undisturbed soils low in available plant foods. The annual harvest of vegetative growth as hay also contributes to the nutrient loss.

This study was conducted to gain further information on the response of native grass hay meadows to rates and combinations of nitrogen and phosphorus in a forty-five inch rainfall area of Oklahoma.

CHAPTER II

REVIEW OF LITERATURE

Some of the earliest work on native grass fertilization in Oklahoma was reported by Harper (1957) who began his studies in 1926 at Stillwater. On a Norge loam soil annual applications of 21 pounds of nitrogen per acre produced 3412 pounds of air dry forage per acre compared to 3097 pounds from the untreated check. This response was 15 pounds of forage per pound of applied nitrogen. Application of 42 pounds of nitrogen, 20 pounds of P_2O_5, and 12.5 pounds of K_2O per acre increased forage production to 4039 pounds. In the 18-year study significant difference from fertilizer treatments occurred in only 3 of the years.

Elder and Murphy (1958) reported the response of native grass to fertilization on a Parsons silt loam soil at Warner, Oklahoma. The four-year average annual production from the check plot was 1826 pounds of air dry forage per acre. The application of 33.5 pounds of nitrogen returned 8 pounds of forage for each pound of nitrogen applied. An application of phosphate increased the production by 256 pounds of forage per acre and a combination of nitrogen, phosphorus and lime increased production 763 pounds over the check.

A reduction in forage yield occurred when 50 pounds of nitrogen was applied to a native meadow which was clipped only in August (Gay, 1964). Two clippings, June and August, resulted in eleven pounds of oven dry forage per pound of applied nitrogen. Increased rates of nitrogen did not result in an increase in pounds of forage per pound of nitrogen applied. Burning plus 50 pounds of nitrogen per acre produced 28 pounds of oven dry forage per pound of applied nitrogen in a single August clipping. When clipped twice the response in forage per pound of nitrogen was the same as the unburned with like treatment. Increased rates of application did not increase the production per pound of nitrogen applied. The study was conducted on a soil which showed an average analysis of 6.0 pH, 4.8 percent organic matter, 7 pounds of phosphorus per acre, 335 pounds of potassium per acre and 0.213 percent nitrogen.

Forty pounds of nitrogen per acre applied the first of June on a native mixed grass meadow in excellent condition in central Oklahoma increased production to 4,500 pounds per acre or 1,200 pounds over the check yield of 3,300 pounds of oven dry forage per acre. This was a response of 30 pounds of forage per pound of applied nitrogen. When 80 pounds of nitrogen per acre was applied the total production was 5,000 pounds of oven dry forage per acre or 21 pounds of forage per pound of applied nitrogen.[3/]

A native grass fertilization study in 1957 and 1958 was conducted in the cross timber area on virgin unplowed land which had had the brush removed (Huffine and Elder, 1960). The predominate

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[3/] Unpublished research data, Oklahoma State University, Dwyer (1963).

cover was composed of desirable tall grasses. Unfertilized grassland produced an average of 1,270 pounds of grass and 363 pounds of weeds per acre. Plots fertilized with 60 pounds of P_2O_5 every 3 years and 33 pounds of nitrogen each year from 1952 to 1956 produced an average of 1,195 pounds of grass and 858 pounds of weeds per acre in 1958. All forage weights were in terms of oven dry material.

Broadcast applications of 30 and 60 pounds of nitrogen per acre produced 4,840 and 5,810 pounds of air dry forage respectively in a Texas coastal prairie study of little bluestem[4/] (Andropogon scoparius Michx.) while the yield from the check was 4,050 pounds per acre (Riewe and Smith 1955). This was a response of 26 and 29 pounds of forage per pound of applied nitrogen from the 30 and 60-pound rates respectively. An application of 60 pounds of P_2O_5 produced 4,900 pounds per acre, but when combined with 30 pounds of nitrogen the yield was 5,430 pounds. Using 60 pounds of nitrogen plus 60 pounds of P_2O_5 produced 6,550 pounds of air dry forage per acre. The Lake Charles clay soil is deep, heavy, and slowly permeable to rainfall. It is very low in available phosphorus and has a range in pH from 6.5 to 6.8.

Unfertilized native vegetation on a Kansas prairie averaged 1,740 pounds of air dry forage per acre while 50 pounds of nitrogen increased this average to 2,460 pounds (Mader 1956). This response was 14 pounds of forage for each pound of applied nitrogen. When 100 pounds each of nitrogen and phosphate were applied, the response increased to 3,200 pounds of forage per acre. The species composi-

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4/ Common plant names will follow Anderson (1961).

tion included little bluestem, big bluestem (*Andropogon gerardi* Vitman), indiangrass (Sorghastrum nutans (L.) Nash.), sideoats grama (*Bouteloua curtipendula* (Michx.) Tor.) plus Kentucky bluegrass (*Poa pratensis* L.), an exotic species.

On a Carrington silt loam soil near Lincoln, Nebraska, native grass to which 60 pounds of nitrogen per acre had been applied produced 4,860 pounds of air dry forage per acre while unfertilized plots produced 1,640 pounds of air dry forage per acre. This was a response of 53 pounds of forage per pound of applied nitrogen. The species composition included western wheatgrass (*Agropyron smithii* Rybd.), porcupinegrass (*Stipa spartea* Trin.), little bluestem and big bluestem (Williams 1953).

The ecosystem of a native grass meadow operates in some form of a dynamic equilibrium among producer, consumer, and decomposer organisms. The addition of fertilizer can be expected to alter the environment of this native grass meadow and this change in environment may favor some species over others.[5/] As a general rule the cool season grasses are favored by nitrogen fertilization.

In Kansas, Kentucky bluegrass increased from 28 percent to 63 percent of the total plant population where various fertilizer treatments were used (Mader 1956). The increased production of Kentucky bluegrass was greatest in the plots which received applications of 100 pounds of nitrogen plus phosphate. Then the drought killed most of the Kentucky bluegrass leaving much bare ground.

Phosphorus fertilization caused an increase in weed growth and a combination of nitrogen, phosphorus and lime changed the

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[5/] Jack R. Harlan, Grasslands of Oklahoma, Process Teaching Series, Agronomy Department, Oklahoma State University (1958).

botanical composition of a native hay meadow in a study by Elder and Murphy (1958). Weedy cool season annual grasses invaded the treated plots and the density of the desirable grasses was reduced. Forage produced was poor quality for livestock use.

Huffine and Elder (1960) reported unfertilized, eroded native pasture produced 16 percent of its total forage in weeds. The area which received phosphate and nitrogen produced 50 percent of its forage as weeds. On the virgin unplowed land the check produced 22 percent weeds while 42 percent of the forage from the fertilized area was weeds.

In the Northern Great Plains a fall application of 90 pounds of nitrogen per acre on a range with a vegetative cover primarily composed of blue grama (Bouteloua gracilis (H.B.K.) Lag. x Steud.), western wheatgrass and needleandthread (Stipa comata Trin. & Rupr.) improved range condition and increased forage production. Two years fertilization was credited with more improvement than six years of complete rest. Most of the increase in yield was due to western wheatgrass (Rogler and Lorenz 1957).

Under semi-arid conditions, downy brome (Bromus tectorum L.) increased greatly where 40 pounds of nitrogen per acre was applied to native grassland. This competition decreased the production of Idaho fescue (Festuca idahoensis Elmer.) and beardless wheatgrass (Agropyron inerme (Scribn. & Smith) Rybd.). A taller and earlier producer, rough bluegrass (Poa secunda Presl.), was not affected by the downy brome competition (Patterson and Youngman 1960).

On a low fertility soil in west central Kansas, Japanese brome (<u>Bromus japonicus</u> Thunb.) and downy brome gave a better response to nitrogen fertilization than did more desirable native grasses including switchgrass (<u>Panicum virgatum</u> L.) and little bluestem. A chemical analysis of the soil showed a pH of 7.9, organic matter 0.5 percent, 20 pounds of available phosphorus and 275 pounds of exchangeable potassium per acre (Launchbaugh 1962).

Cool season grasses, western wheatgrass and needleandthread responded rapidly in the Northern Great Plains as shown by deep green color and increased growth when nitrogen was applied in the fall. The hay yield per pound of nitrogen favored the 30-pound of nitrogen per acre rate. The soil was a Williams [illegible] loam with a relatively high nitrogen content in the upper six inches of soil (Rogler and Lorenz 1957).

In an area of 12 to 13 inches of annual rainfall, Patterson and Youngman (1960) found native plants can effectively use up to 40 pounds of applied nitrogen per acre. Crested wheatgrass (<u>Agropyron desertorum</u> (Fisch.) Schult.) produced 27 pounds of forage for each pound of applied nitrogen.

Fertilized crested wheatgrass, on a Eakin silt loam soil, produced 9.5 and 9.2 pounds of forage per pound of applied nitrogen at the 30 and 60 pounds of nitrogen per acre rate respectively. Over a 12-year period an annual application of 60 pounds of nitrogen per acre on undisturbed sod produced 2,265 pounds of forage per acre. The yield was 1,660 pounds more than the check (Lorenz and Rogler 1962).

On a Ft. Collins silty clay loam soil an application of 80 pounds of nitrogen per acre gave a response on intermediate wheatgrass (Agropyron intermedium (Host) Beauv.) of 18 pounds of forage per pound of applied nitrogen. When 160 pounds of nitrogen was applied the response was 21 pounds of forage per pound of nitrogen. On tall wheatgrass (Agropyron elongatum (Host) Beauv.) the response from an 80-pound nitrogen application was 30 pounds of forage per pound of nitrogen (Dotzenko 1961).

In Oklahoma studies on native grass fertilization Harper (1957) reported an 18-year study in which it was found that as the amount of moisture received increased there was an increase in forage yield. Elder and Murphy (1958) found that June rainfall was an important factor in native grass response to fertilization. The best response occurred in years when June precipitation was highest.

A western South Dakota study by Cosper and Thomas (1961) found precipitation a limiting factor in native grass response to fertilization. An increase in precipitation would require a higher fertilizer rate to reach maximum forage production. The total forage production would also be higher. Conversely a decrease in precipitation would result in a lower fertilization rate to reach maximum response. The total forage production would be lower. The soil was an Orman clay loam with a pH of 7.5, low in available phosphorus and high in total nitrogen.

Moisture played an important role in the production of grasses at Swift Current, Saskatchewan, Canada. Hay yields from crested wheatgrass fertilized with nitrogen were economical most years while

Russian wildrye (*Elymus junceus* Fish.) achieved economical yields only during the wet years. There was no response from any of the grasses to the application of phosphorus (Kilcher 1958).

CHAPTER III

MATERIALS AND METHODS

The study area was located three miles east and two miles south of Poteau, Oklahoma in LeFlore County. The study plot area was further located as in the northeast quarter of the SW$\frac{1}{4}$, NW$\frac{1}{4}$, Sect. 3, T6N, R26E. There are several native hay meadows in this part of the county. All of the meadows are on upland soils since the bottomland soils of this area orginally had a forest type of vegetative cover.

The soil of the study area is a Dennis loam with four percent slope to the east. The A horizon is 10 inches in thickness and classified as a loam texture. The B horizon, a clay loam, is 10 inches to 24 inches in depth. A layer (B_3) consisting of clay loam with shale fragments occurs from a depth of 24 to 30 inches. Unweathered shale is encountered at about 30 inches but varies from 20 to 36 inches over the site.

The point-centered quarter method reported by Dix (1961) and Crockett (1963) was used to sample the vegetative cover. Fifty-six observations were recorded with two samples taken from each plot. The vegetative measurements were made in June, 1963.

The dominant grasses of the native hay meadows of the area are big bluestem, little bluestem and indiangrass. Arrowfeather threeawn (*Aristida purpurascens* Poir), broomsedge (*Andropogon virginicus* L.)

and Carolina jointtail (Manisuris cylindrica (Michs.) Kuntze) were the less desirable grasses.

The relative frequency of the dominant species was 25 for indiangrass, 22 for little bluestem, and 15 for big bluestem. Actual frequency, relative density, and absolute density of these species was also in the same order.

The dominant forbs on the site were plains wildindigo (Baptisia leucophaea Nutt.), Virginia tephrosia (Tephrosia virginiana (L.) Pers.) and pale echinacea (Echinacea pallida Nutt.).

The species densities and frequencies for the study area are presented in Appendix Table IV. Species were identified by the use of Waterfall's (1962) Manual. The area would be classed as a loamy prairie range site in excellent condition.

A randomized block design with seven treatments in four replications was used. The treatments were 50 pounds of nitrogen per acre as urea, 50, 75 and 100 pounds of nitrogen per acre as ammonium nitrate, 50 pounds of nitrogen as ammonium nitrate plus 11 pounds of phosphorus as treble superphosphate, 17.5 pounds per acre of phosphorus only as treble superphosphate and the untreated check.

A soil analysis prior to the study showed the surface soil had a pH of 5.1, contained 4.1 percent organic matter, 17 pounds of phosphorus and 140 pounds of exchangeable potassium per acre with 0.205 percent nitrogen. Soil samples from three other native meadows in the area were very similar in chemical analyses.

Fertilizer material was broadcast on the plots on May 2, 1963 and May 1, 1964. The plots were fertilized with commercial grade fertilizer material containing 33.5 percent nitrogen as ammonium nitrate, 45 percent nitrogen as urea and 46 percent P_2O_5 as treble superphosphate.

Five samples 11.5 x 24 inches were harvested from the north one-half of each plot on about July 3 of each year. Five similar samples were harvested from the south part of each plot on about August 18 each year. No area sampled in a previous clipping was harvested again.

All clippings were made at ground level of the current seasons growth. There were no separations made of the July clippings, but the August clippings were separated into five categories: indiangrass, little bluestem, big bluestem, other grasses, and forbs. The samples were air dried, then weighed on gram scales and the results converted to pounds of air dry forage per acre.

CHAPTER IV

RESULTS AND DISCUSSIONS

Drought conditions prevailed during the two years in which this study was made. The ten year average precipitation and that received during the study period are shown in Appendix Table I. The precipitation for the two years of the study was approximately one-half and two-thirds respectively of the normal for the area.

All nitrogen treatments yielded significantly more forage than the check (Appendix Table II). The greatest response to nitrogen was produced at the 50 pounds per acre rate in 1963 (Figure I). The 50-pound rate produced 23 pounds of forage for each pound of applied nitrogen. In 1964 this production was only 10 pounds of forage for each pound of nitrogen. Additional nitrogen above the 50-pound rate produced no significant difference in the yield of total forage per acre.

The application of 50 pounds of nitrogen per acre as urea produced no significant difference in forage yields over the check. When compared with urea, the application of 50 pounds of nitrogen as ammonium nitrate showed a significant difference in 1963 only. The 50 pounds of nitrogen as ammonium nitrate produced 975 pounds more air dry forage per acre than the urea treated plot. In 1964 the difference was only 140 pounds of forage per acre (Figure 2).

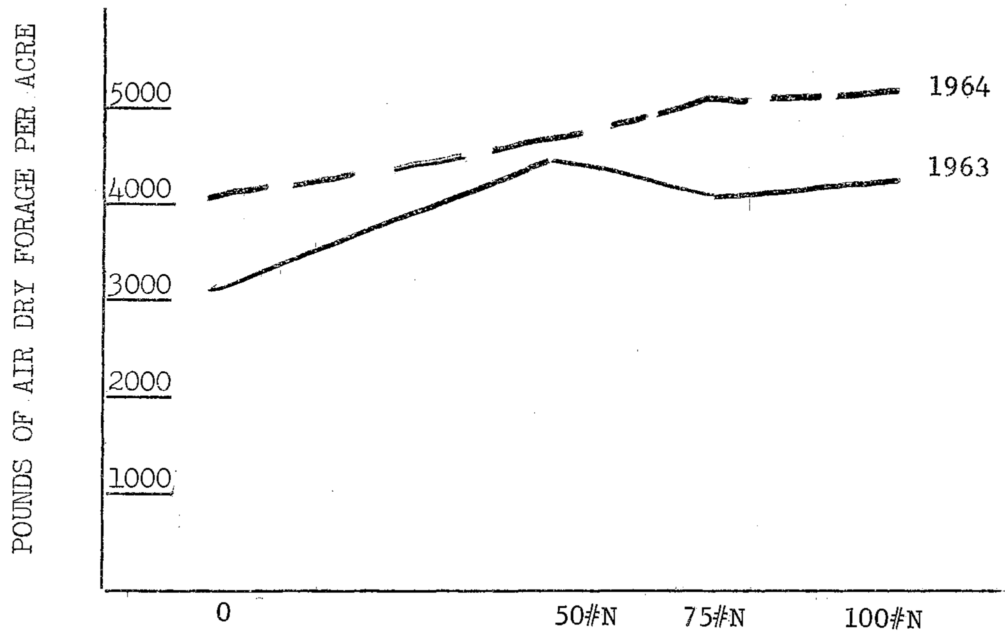

Figure 1. Rates of Nitrogen and Forage Yields - July

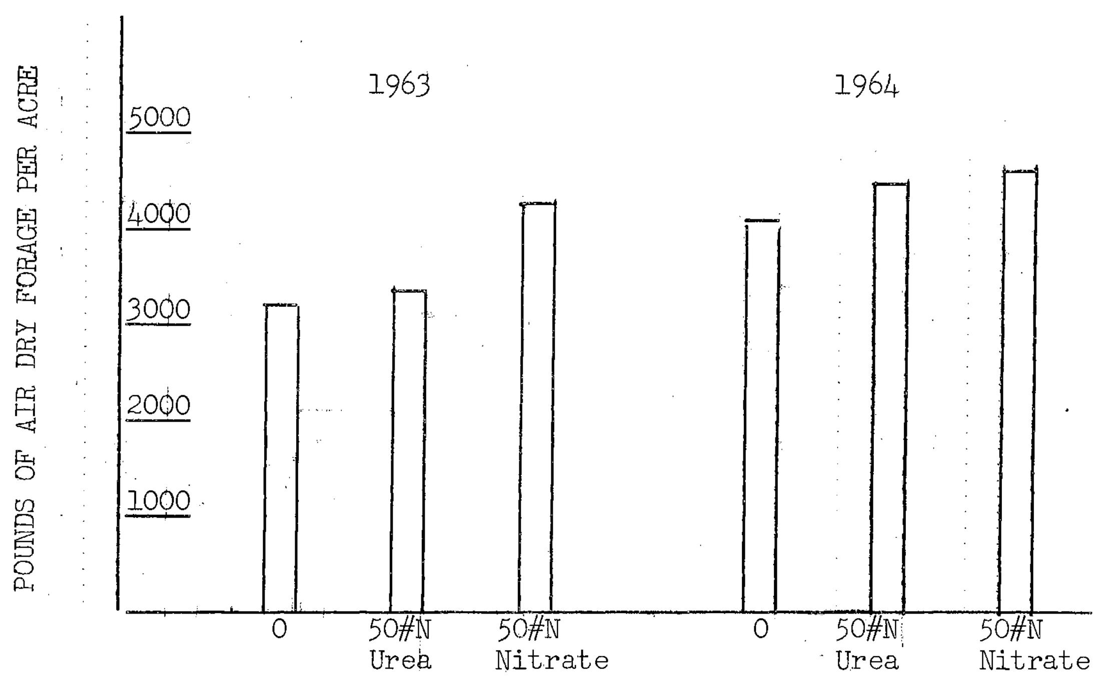

Figure 2. Source of Nitrogen and Forage Yield - July

There was no significant difference in the production from the use of 17.5 pounds of phosphorus alone when compared to the check (Figure 3). There was a significant yield increase when 11 pounds of phosphorus and 50 pounds of nitrogen were used. This combination produced 848 and 915 pounds of air dry forage more than the check in 1963 and 1964 respectively. There was no significant difference in the combination of phosphorus and nitrogen when compared to the use of 50 pounds of nitrogen only.

All rates of nitrogen showed a significant increase over the check in the August clipping (Figure 4). However, there were no significant differences between nitrogen treatments except at the 100-pound rate in 1964. This yield was 2,313 pounds of air dry forage per acre more than the check and 985 pounds more than the 50-pound rate. Again the 50-pound rate produced more forage for each pound of applied nitrogen than the higher nitrogen rates. The 50-pound rate produced 26 pounds of forage and the 100-pound rate 23 pounds for each pound of applied nitrogen. The 75-pound rate produced 18 pounds of forage for each pound of applied nitrogen.

The application of 50 pounds of nitrogen as urea showed a significant increase in production over the check only in August, 1964 (Figure 5). This increased production was 1,115 pounds per acre of air dry forage. There was no significant difference in the production from either form of nitrogen in any year. In 1964 the urea plot produced 22 pounds of forage for each pound of applied nitrogen.

Phosphorus alone did not show a significant difference over the check in forage production in August. When 11 pounds of phosphorus plus 50 pounds of nitrogen were used the response was significant over

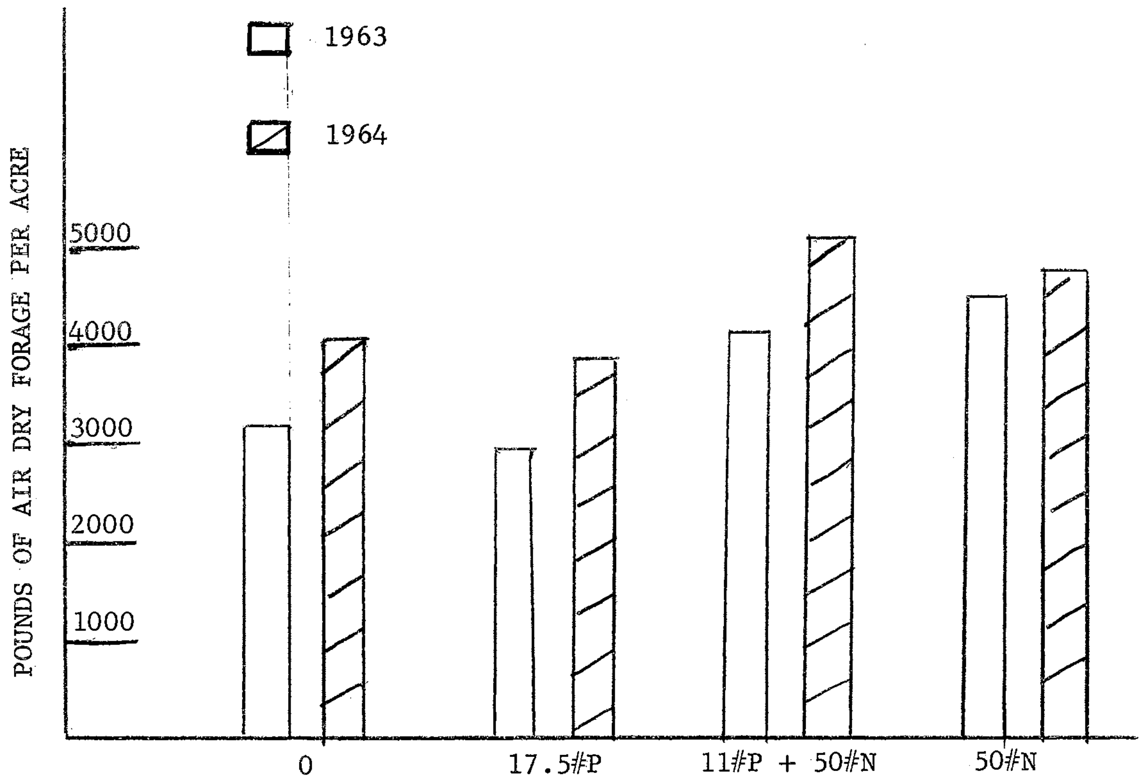

Figure 3. Phosphate and Forage Yields - July.

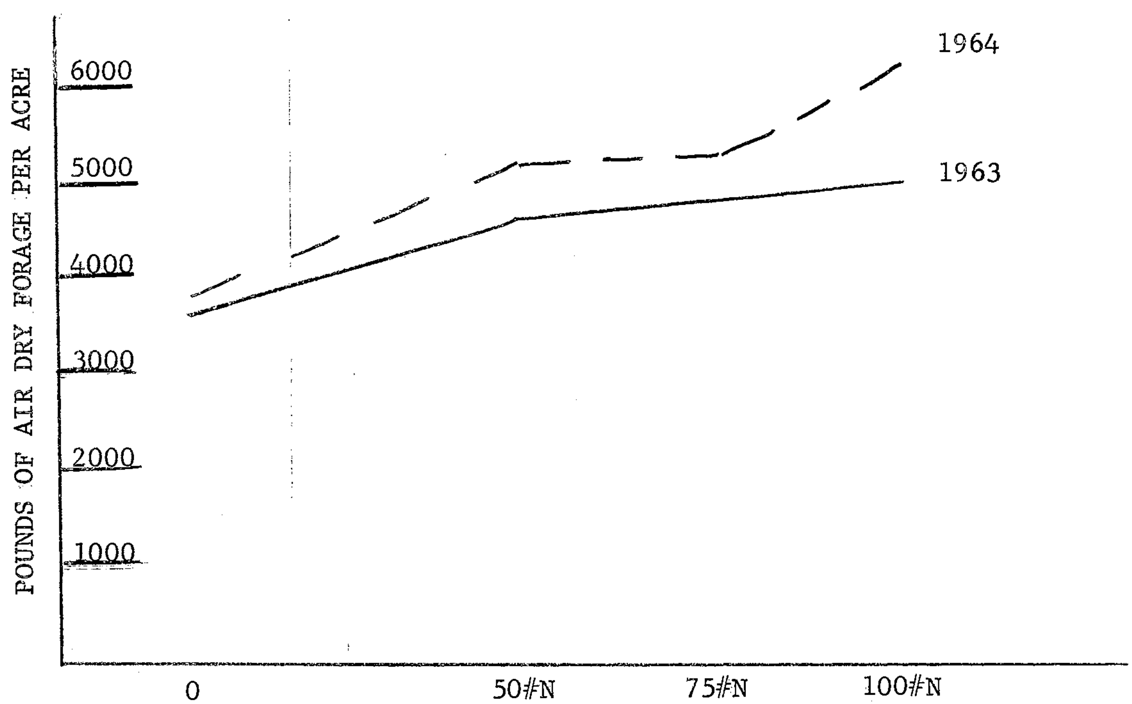

Figure 4. Rates of Nitrogen and Forage Yield - August.

the check. This was an increase of 815 and 1,733 pounds per acre in 1963 and 1964 respectively. This increase was not significantly different from the response received from the application of 50 pounds of nitrogen (Figure 6).

The fertilizer treatments were on the plots approximately 60 days prior to the July clipping each year. This may not have been long enough for the plants to make full use of the added available plant nutrients. The forage growth of the nitrogen-fertilized plots exceeded the production from the check even though the loss of succulence was more apparent at a slightly earlier date with the nitrogen treatments. This indicated that the increased nitrogen aided the plants to make better use of the available moisture.

Annual response by species to fertilizer treatment is shown in Appendix Table III. Indiangrass made the greatest response in forage production when nitrogen was applied at the 75 pound rate. This was an increase of 963 and 1,249 pounds per acre over checks in 1963 and 1964 respectively. The urea treatment and the phosphate treatments were ineffective in increasing production.

Little bluestem produced the greatest response to nitrogen at the 50-pound rate. This production was 780 and 833 pounds over the checks for 1963 and 1964 respectively. Higher rates of nitrogen did not increase the production over the 50-pound rate. Urea was less effective than ammonium nitrate. There was no production response from the use of phosphorus.

Big bluestem response was somewhat erratic in comparison with indiangrass and little bluestem in that urea was superior to ammonium nitrate, phosphate gave an increased forage yield, and low rates of

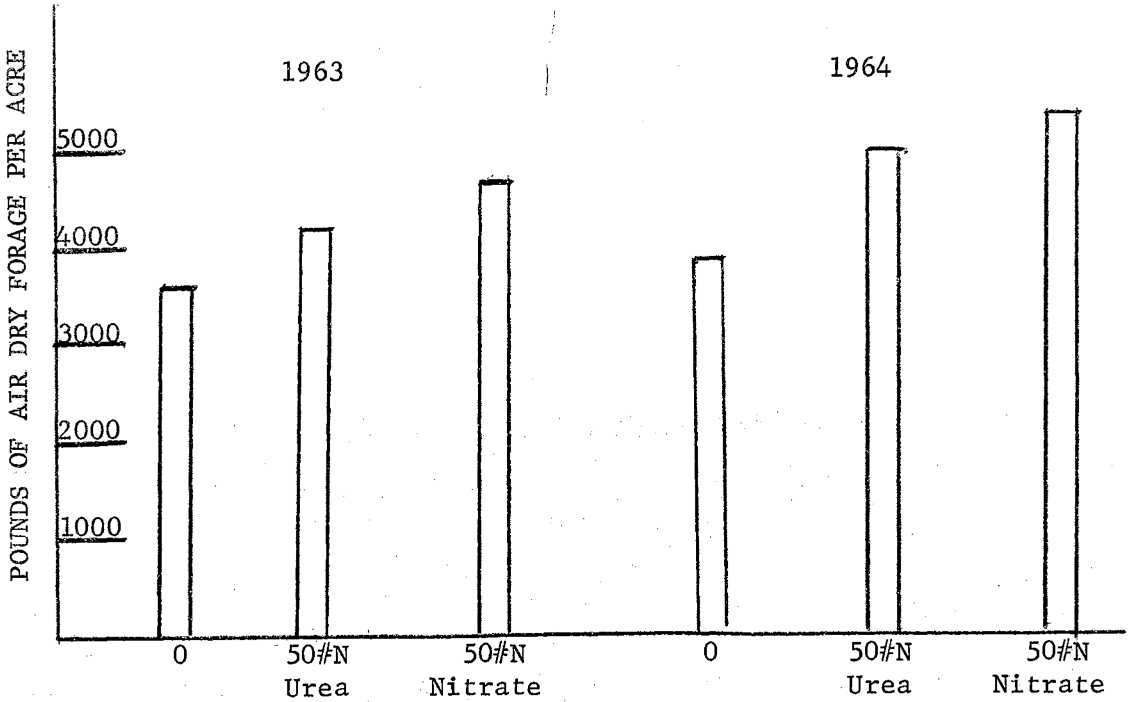

Figure 5. Source of Nitrogen and Forage Yield - August.

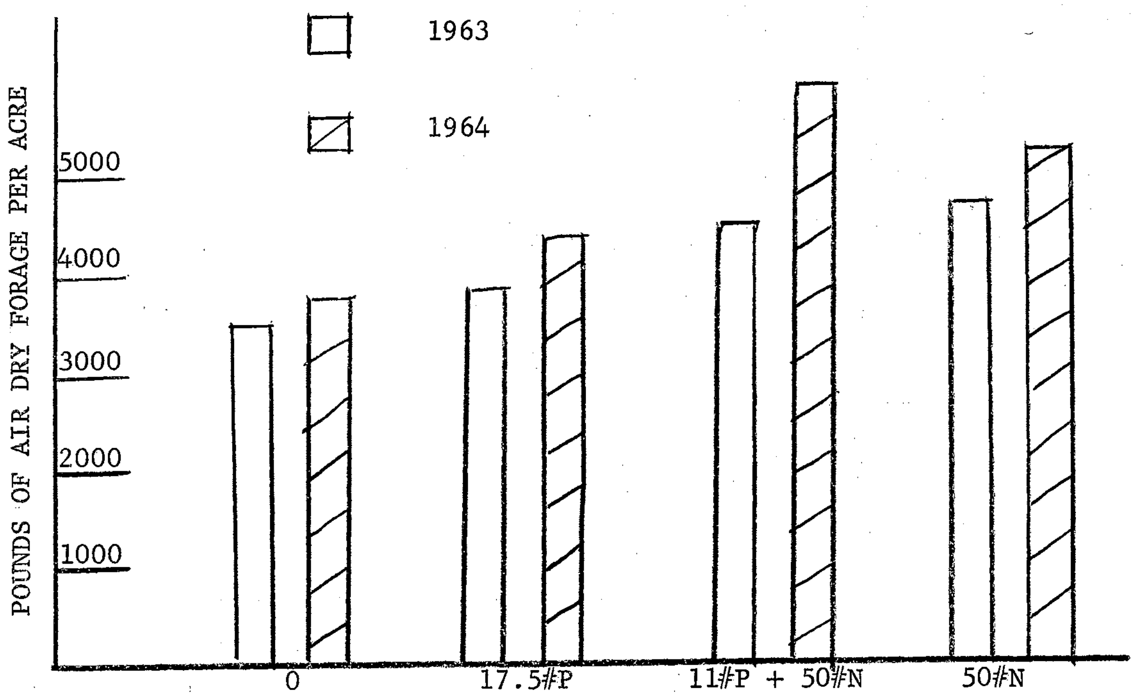

Figure 6. Phosphate and Forage Yields - August.

ammonium nitrate were less effective than the 100-pound rate of nitrogen.

Response of the other grass species to fertilization was negligible. The response of forbs was variable and no trends were established.

In the sampling of the study area little bluestem was found to occur as an aggregate population. Dix (1961) advanced the objection that the point-centered quarter method densities were true only for randomly distributed species. Cottam and Curtis (1956) found that densities of aggregate species were below the actual densities for the species. Crockett (1963) also found the point-centered quarter method provided good densities only when species were randomly distributed. This perhaps explains why little bluestem, though second ranked to indiangrass in this study area, out produced the first ranked species in pounds of air dry forage per acre. There were many small stems of indiangrass in the study area.

Sample plots clipped at the ground level in the study area on the third of July had made no noticeable regrowth by late July. The regrowth on the clipped plots was none to slight at the time of the first killing frost in the fall.

The adjacent meadow area was mowed during the first week of July each year. The average height of the mowing was four inches. By late July of each year the meadow area had a regrowth of eight to ten inches from the ground level.

The study area was not disturbed by a uniform mowing as would be true under hay meadow management. The plots were sampled and then grew undisturbed until frost. In January the study area was cut with a rotary mower. The value of the year's rest from clipping was not measured. There would seem a need for more work with this factor taken into the measurements.

CHAPTER V

SUMMARY

A study of native grass response to fertilization with three rates of nitrogen, two of phosphorus and a combination of both was made in LeFlore County, Oklahoma.

The soil was a Dennis loam which is strongly acid, low in phosphorus and medium in exchangeable potassium.

The native grass hay meadow was in excellent range condition with the frequency of indiangrass 61 percent, little bluestem 54 percent and big bluestem 38 percent.

Commercial grade ammonium nitrate, urea, and treble superphosphate were broadcast on the plots in early May. Five samples, 11.5 x 24 inches, were clipped at ground level for forage yield on July 3 and August 18 of each year. Species separations were made of the August clipping.

The precipitation for the period of the study was well below normal with severe drought conditions each summer.

All nitrogen treatments, as ammonium nitrate, yielded significantly more than the check. The greatest response in terms of pounds of forage per pound of nitrogen was produced at the 50-pound rate. In July 1963, this was 23 pounds of forage for each pound of applied nitrogen. In August 1964, the response was 26 pounds of forage for each pound of applied nitrogen. Additional nitrogen above the 50-pound rate produced no significant difference in the yield of total forage per acre.

The favorable comparison between the two forms of nitrogen used indicates equitable plant response to either form of nitrogen under these conditions.

Phosphorus alone did not produce a significant difference in plant response. The use of phosphorus with nitrogen did not prove beneficial when compared with nitrogen alone.

Indiangrass, little bluestem and big bluestem responded to nitrogen fertilization. Big bluestem continued a response to higher rates of nitrogen in August. Other grasses and forbs did not achieve any great increase in production due to fertilization. Phosphorus did not cause an appreciable increase in production of other species.

Cool season weedy grasses did not invade the nitrogen fertilized plots. There was a carry-over of nitrogen as indicated by green color prior to second year application of fertilizers.

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APPENDIX

TABLE I

PRECIPITATION DATA IN INCHES[1/]

Month	Year 1961	1962	1963	1964	Mean 1953--1962
January	1.69	2.51	0.81	0.60	2.21
February	3.08	3.09	0.24	2.88	2.94
March	4.92	2.78	2.93	4.59	4.30
April	1.70	2.73	4.46	5.65	4.13
May	12.24	1.24	1.87	5.99	7.07
June	3.26	5.63	1.50	0.44	3.19
July	8.16	5.29	3.03	0.82	4.84
August	2.56	2.30	0.58	6.49	3.78
September	5.81	3.87	1.87	4.72	3.12
October	3.11	8.17	T	T	3.09
November	6.17	3.41	1.58		3.49
December	3.76	0.85	2.09		3.00
Total	56.46	41.87	20.96		45.16

1/ United States Weather Bureau Station Records, Poteau, Oklahoma.

TABLE II

FORAGE PRODUCTION PER ACRE AS POUNDS OF AIR DRY MATTER

Treatment	July 1963	July 1964	August 1963	August 1964
Check	3187 a 1/	4017 ab	3592 a	3772 a
50 N Urea	3357 a	4437 ac	4090 abc	4887 bc
50 N 2/	4332 b	4577 cd	4687 cd	5100 c
75 N	3965 b	4970 cd	4802 c	5255 c
100 N	4172 b	5050 d	4845 d	6085 d
50 N + 11 P	4035 b	4932 cd	4497 bcd	5505 cd
17.5 P	2932 a	3747 b	3805 ab	4340 ab

1/ Treatment means within a column followed by the same letter are not significantly different at the .05 level.

2/ Nitrogen as Ammonium Nitrate.

TABLE III

SPECIES RESPONSE IN POUNDS OF AIR DRY MATTER PER ACRE--AUGUST

Treatment	Year	Age[1/]	Asc	Snu	Other	Forbs	Total
Check	1963	437	975	748	687	745	3592
	1964	566	1207	905	538	566	3772
50 N Urea	1963	683	1232	853	717	605	4090
	1964	977	1759	928	635	588	4887
50 N	1963	520	1755	1065	607	740	4687
	1964	459	2040	1275	561	765	5100
75 N	1963	550	1313	1710	487	742	4802
	1964	788	1314	2154	420	579	5255
100 N	1963	610	1560	1130	738	807	4845
	1964	1156	1886	1339	852	852	6085
50 N + 11 P	1963	558	1647	800	787	615	4407
	1964	936	1927	1156	826	660	5505
17.5 P	1963	525	995	870	568	847	3805
	1964	825	998	1128	564	825	4340

1/ Age, Asc, and Snu signify big bluestem, little bluestem, and indiangrass, respectively.

TABLE IV

SPECIES DENSITY AND FREQUENCY DETERMINED BY THE POINT-CENTERED QUARTER METHOD

Species	Number of Quadrats	Number of Hits	Sum of Distances	Relative Frequency	Species Frequency	Relative Density	Absolute Density (Shoots per sq. Meter)
Sorghastrum nutans	34	74	306	24.82	60.71	33.04	211.79
Andropogon scoparius	30	57	191	21.90	53.57	25.45	163.14
Andropogon gerardi	21	29	152	15.33	37.67	12.95	83.01
Aristida purpurascens	10	14	61	7.30	17.85	6.25	40.06
Carex species	10	13	40	7.30	17.85	5.80	37.18
Andropogon virginicus	9	9	25	6.57	16.07	4.02	25.79
Tephrosia virginiana	6	8	39	4.38	10.71	3.57	22.88
Manisuris cylindrica	6	6	29	4.38	10.71	2.68	17.18
Ruellia humilis	4	5	16	2.92	7.14	2.23	14.29
Panicum scribnerianum	2	3	3	1.46	3.57	1.34	8.59
Baptisia leucophaea	2	2	10	1.46	3.57	0.89	5.70
Rosa setigera	1	2	5	0.72	1.78	0.89	5.70
Aster ericoides	1	1	1	0.73	1.78	0.44	2.82
Eragrostis spectabilis	1	1	8	0.73	1.78	0.44	2.82
Total	137	224	886	100.00		99.99	640.95

VITA

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Master of Science

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